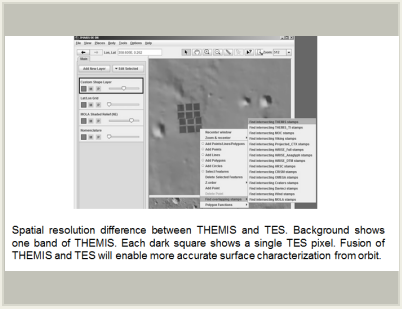
Fusion of THEMIS and TES for Accurate Mars Surface Characterization, Phase I

Completed Technology Project (2017 - 2018)

Project Introduction

In a recent NASA ROSES solicitation, NASA has expressed strong interest in improving surface characterization of Mars using orbital imagers. Thermal Emission Imaging System (THEMIS) and Thermal Emission Spectrometer (TES) are orbital multispectral imagers of Mars. THEMIS has 10 spectral bands in the 6-13 micrometers region and a spatial resolution of 100 m. TES has 143 spectral bands in the 5-50 micrometers range, but with low spatial resolution of 3x3 km. Although both have been used to map out the surface composition of Mars, there are some limitations. First, THEMIS has low spectral resolution that may not provide accurate surface characterization. Second, TES has low spatial resolution that cannot provide fine spatial details of surface characteristics. Roughly speaking, each TES pixel contains about 900 THEMIS pixels. It is therefore very challenging to fuse the two data sets. We propose a novel and accurate framework that can deal with the above challenge. The framework is based on the latest development in image registration, image fusion, anomaly detection, pixel classification using hyperspectral images, and concentration estimation. First, a two-step image registration algorithm is proposed to align the THEMIS and TES bands. Subpixel accuracy can be achieved. Second, a novel image fusion algorithm is proposed to fuse THEMIS and TES bands to generate an image cube with 143 bands of 100-m resolution images. Our algorithm has been proven to be better than state-of-the-art fusion algorithms. Third, we propose a novel anomaly detection algorithm for detecting interesting regions in the fused image cube. This algorithm is known as cluster kernel Reed Xiaoli (CKRX) and has high performance in anomaly detection. Fourth, a sparsity based approach is proposed to perform accurate rock classification. Finally, a deep learning based algorithm is proposed to estimate the chemical composition of the rocks for better surface characterization.



Fusion of THEMIS and TES for Accurate Mars Surface Characterization, Phase I Briefing Chart Image

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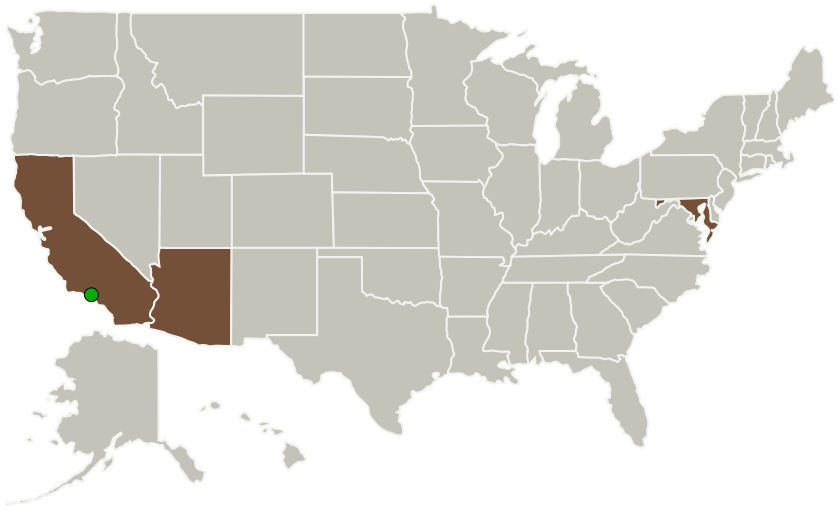
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Applied Research, LLC	Lead Organization	Industry Minority-Owned Business	Rockville, Maryland
Arizona State University-Tempe(ASU)	Supporting Organization	Academia Alaska Native and Native Hawaiian Serving Institutions (ANNH)	Tempe, Arizona
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
Arizona	California
Maryland	

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Applied Research, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

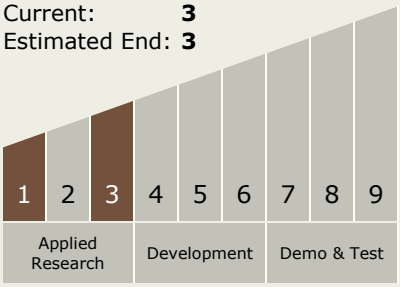
Carlos Torrez

Principal Investigator:

Chiman Kwan

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**



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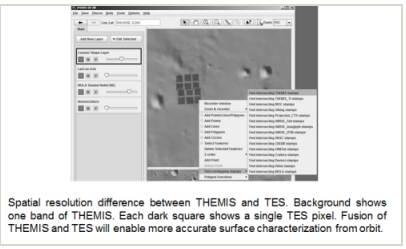
Images



Briefing Chart Image
Fusion of THEMIS and TES for Accurate Mars Surface Characterization, Phase I Briefing Chart Image
(https://techport.nasa.gov/image/130777)

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.3 Distributed Aperture

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System